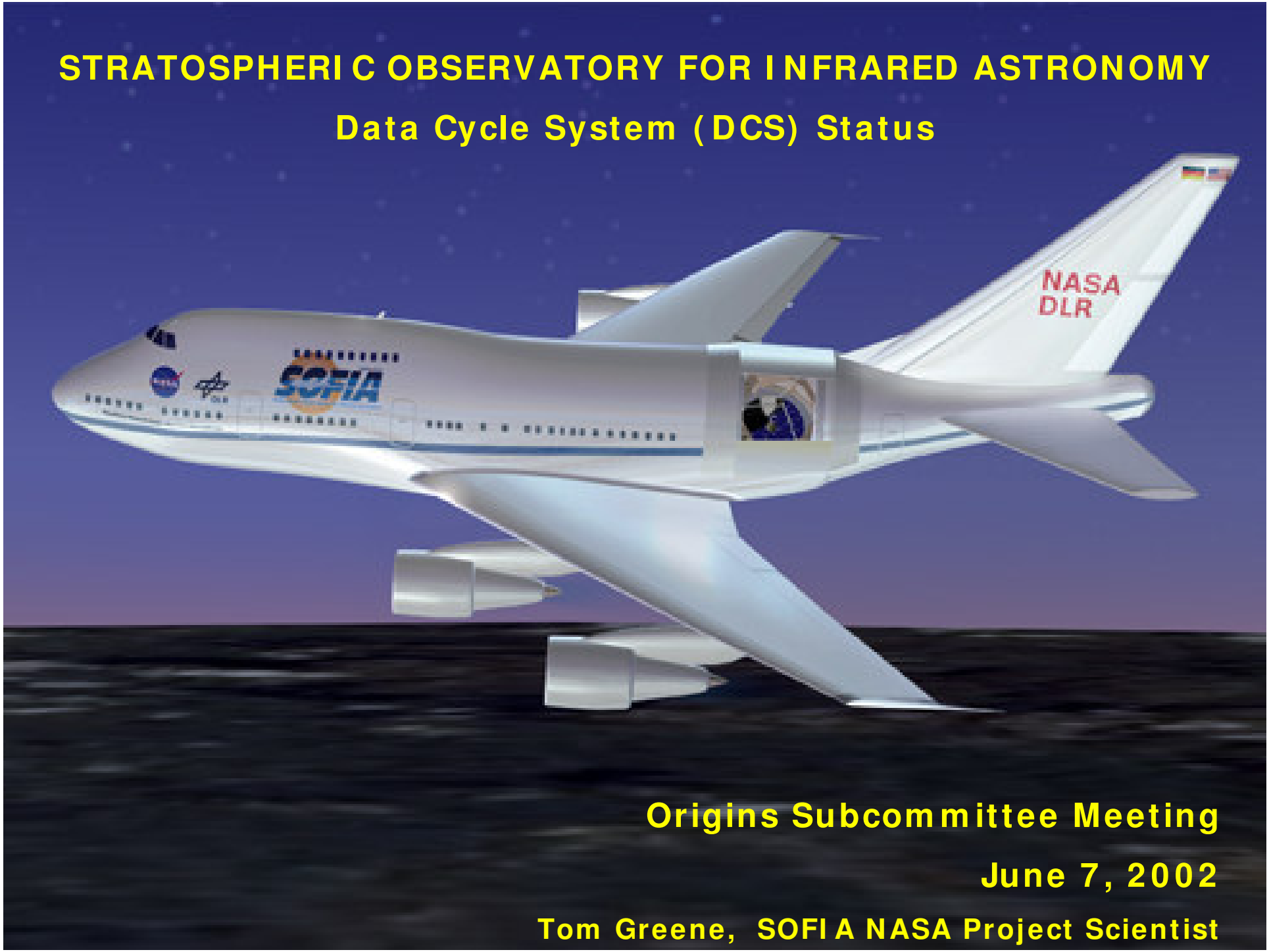
STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY

Data Cycle System (DCS) Status



Origins Subcommittee Meeting

June 7, 2002

Tom Greene, SOFIA NASA Project Scientist

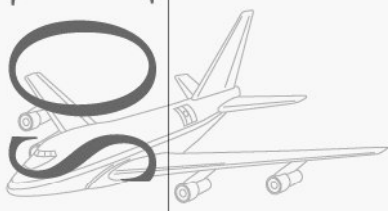
Outline

- DCS Purpose
- DCS Science Requirements
- DCS Architecture and Implementation
- DCS Status: Team, Schedule, Budget
- DCS Concerns

NOTE: SOFIA is a privatized mission, with USRA being the prime contractor for development and operations.

DCS Purpose

- The DCS is the interface that a general observer uses on SOFIA for:
  - Proposal preparation
  - Observation planning
  - (Facility instrument) configuration (Web → AOT → AOR → Instrument)
  - Archiving science and housekeeping data
  - (Facility instrument) data reduction: Quick Look and Pipelines
  - Archival research and analysis



Stratospheric Observatory for Infrared Astronomy

SOFIA

A NASA Origins Mission

DCS (Initial) Limitations

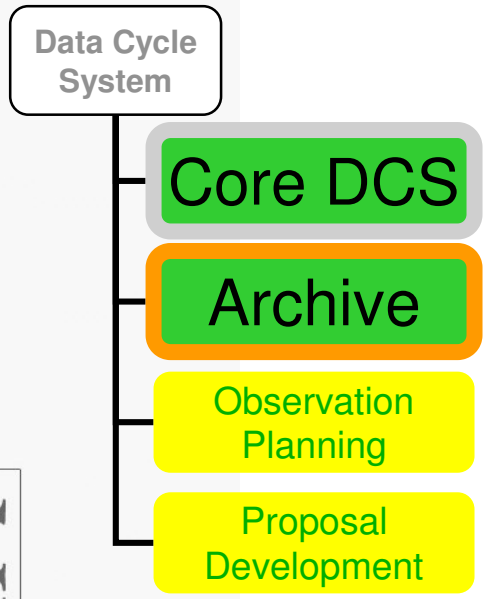
The DCS will provide a high-quality interface for observing with SOFIA and for accessing its data. However:

- Only certain modes of the facility instruments will be supported at first light; more modes and PI instruments will be added later
- User interfaces will not be finalized at first light, and some DCS functionality (i.e. Quick Look data analysis while observing) will be provided by the instruments then
- Data reduction pipelines will not be finalized at first light; they will be improved as the instruments are more fully characterized
- Interactive data analysis tools (e.g. IRAF packages or IDL scripts) will support only selected modes of facility instruments at first

DCS Minimum Science Requirements

- Proposal Preparation and Observation Planning
  - Observing time estimators and data overlays
  - Astronomical Observing Templates (AOTs), proposal submission
- In-flight Quick Look
  - Implemented by instrument teams at first light
- Data Archive
  - Search, browse, & retrieve SOFIA science and housekeeping data
  - Extract raw or reduced/calibrated science data in FITS or other formats
  - Summary Archive (observing logs)
- Data Pipelines
  - Selected modes of facility instruments (expanded during operations)
  - Code provided by instrument teams & hosted by DCS
- Interactive Data Reduction (addition)
  - Packages provided by fac. instrument teams; USRA will help HAWC
- Flight Planning & Scheduling moved to Flight Management

DCS Design: Components



- Core DCS
  - Primary user interface
  - Ast. Observ. Record (AOR) generation
  - Pipelined data reduction
- Archive
  - Repository for Science and MCCS data
  - Retrieval of data products
- Observation Planning & Visualization
  - Graphical interface and data overlays
  - Observing time estimators
- Proposal Development
  - Proposal preparation & submission tools
  - Proposal parsing and management

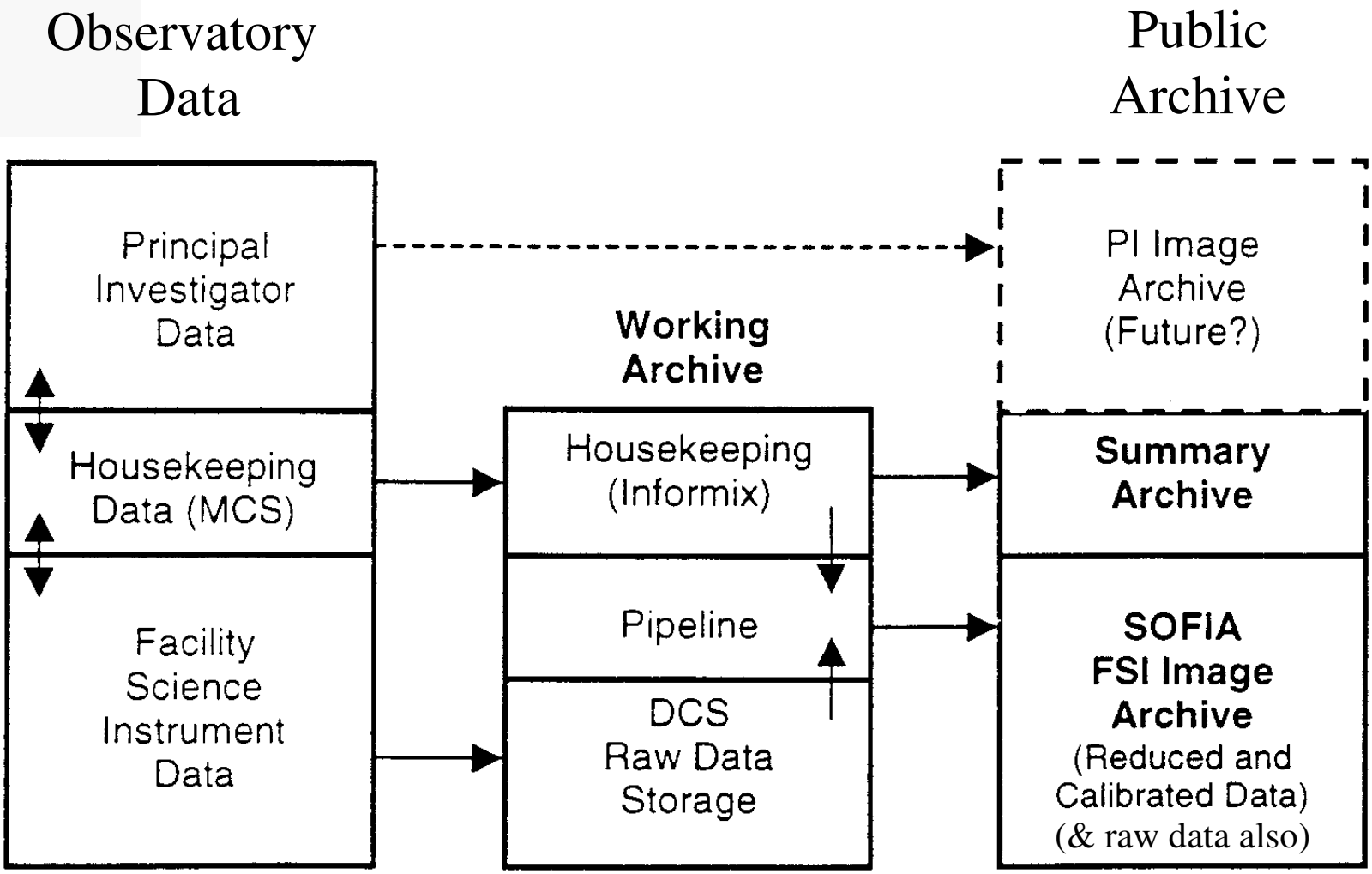
DCS Design: Philosophy

- Modular
  - Integrated independent services
  - Distributed on several hosts
- Extensible
  - Easy to incorporate new data types and tasks over SOFIA lifetime
  - Able to use existing packages (e.g. IDL pipelines)
- Maintainable
  - Platform- and vendor-independent as possible
  - Use of open, accepted non-proprietary standards
  - Well documented
- Re-use existing software whenever possible & appropriate
- Coordinate and communicate with other archives (i.e. IPAC, also NVO)

DCS Core Architecture Components

- User interface
  - For general observers (via Internet) and SSMOC
- Task library
  - Defined tasks are brains of DCS
- Data reduction resources
  - Execute pipelines
- (Facility) science instrument and MCCS interfaces
  - Send AOR information / commands to instruments
  - Collect data from instruments and MCCS (telescope system)
- Interface with Archive

DCS Archive

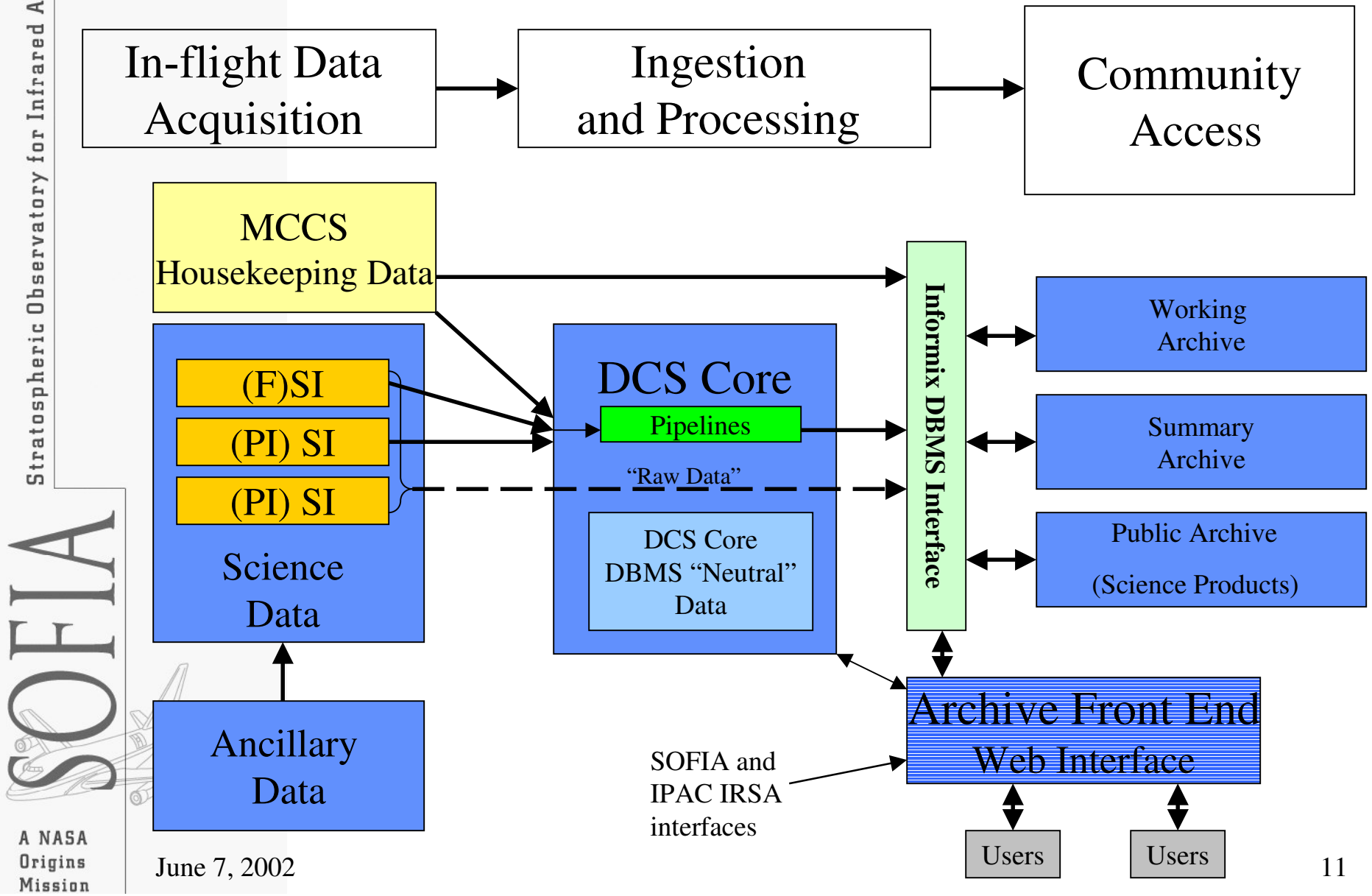


Raw science data are accessible via archive in addition to pipeline reduced data and housekeeping data

DCS Archive Design / Technologies

- Commercial INFORMIX database
  - Robust
  - Uses standard SQL commands (will minimize proprietary ones)
  - Selected for features and acquired at low cost (few $K)
- Re-use of ISO Archive user interface
  - Similar in function, database interface, some data types
  - Source code available
- Can accept and write FITS or other described file formats
  - Internal format is INFORMIX for headers & housekeeping data
  - Science data stored in native binary format
- Stores (and processes via the Core) both housekeeping and science data
- Following NVO developments and will interface once standards defined
- Will also be accessible via IPAC IRSA interface (draft letter of intent)

DCS Data Acquisition, Processing, and Retrieval



Preparation & Data Analysis Tools

- Observation Planning
  - Web-based observatory and instrument documentation; also observing time estimators
  - Existing observation planning tool will be used (modified)
  - Planning tool with overlays of different data and SOFIA instrument fields / apertures
- Proposal Development
  - Proposal preparation tool: LaTeX template, Web-entry, or local
  - Proposal handling / parsing tool and proposal database
- Packages for Interactive Data Reduction / Analysis
  - IRAF or IDL scripts for certain facility instrument modes: to be provided by instrument teams (USRA to support HAWC)

Implementation: DCS Team (and current FTE)

- USRA (~ 0.5 FTE now; staff up in FY04)
  - Management
  - Science oversight
  - Systems engineering: DCS / MCS interface, standards, etc.
- RIT: (~ 2 FTE)
  - DCS Core (AOTs, AORs, data acquisition / pipeline infrastructure)
- UCLA (~ 2→ 3 FTE)
  - DCS Archive
  - FITS standards
- NASA ARC (~ 1 FTE)
  - Observing time estimators; possibly other items
- Facility Instrument Teams
  - ~ Monthly telecons, TIM in late July, HAWC, FORCAST, FLITECAM visits so far

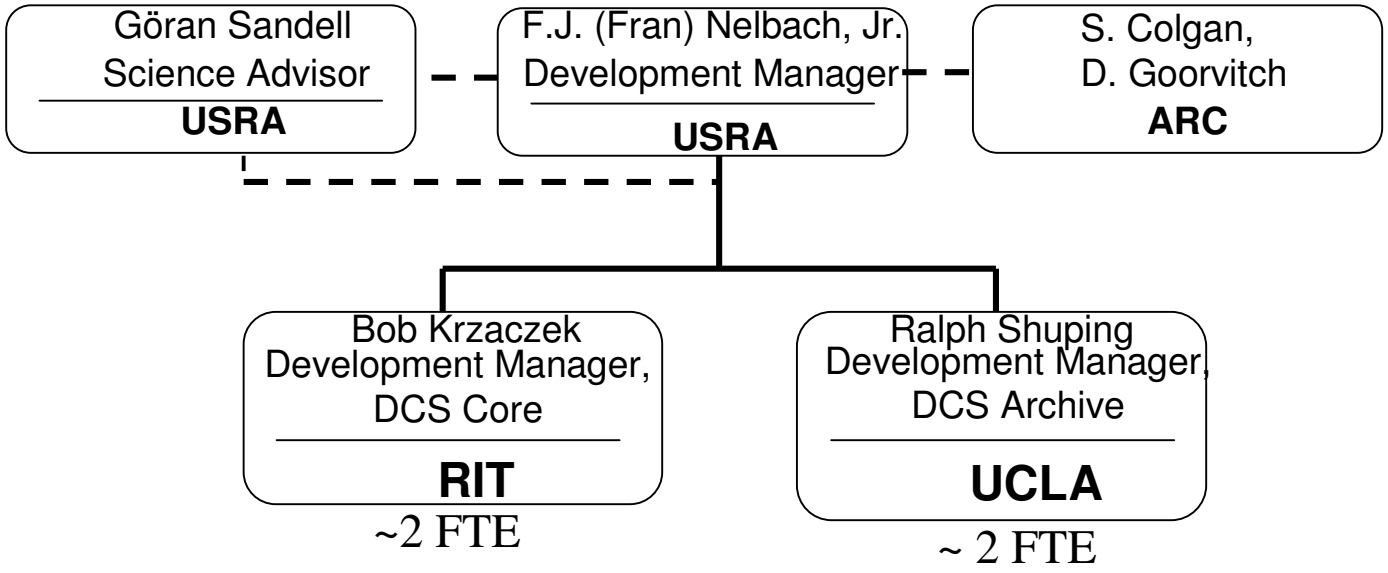
Allocation Of DCS Tasks

ID	Capability	Development Organization[1]
1.0	Archived housekeeping data and raw science data for all instruments.	UCLA
1.1	Summary archive of all observations.	UCLA
1.2	Searchable archives with data retrieved in both native format and FITS.	UCLA
2.0	Pipeline reduced data from facility and test instruments, with the understanding that instrument teams design the pipelines.	RIT
3.0	AOT editors and the ability to submit a valid AOR to facility instruments	RIT
4.0	Integration and interoperability of the DCS, MCS and science instruments.	UCLA, RIT, USRA
4.1	Quick-Look in-flight data display	Instruments, USRA
5.0	Proposal tool and proposal handling software.	TBD[2]
6.0	Observation Planning Tools	TBD[2], ARC
7.0	Interactive data reduction packages	Instruments, USRA [2]

[1] USRA has ultimate responsibility for DCS development

[2] These items will re-use existing software at first light. Their allocation is pending the outcome of re-use studies

DCS Management and Key Personnel



- Program Manager: Fran Nelbach, USRA (Info Sys Dev Manager)
- Lead Systems Engineer: R. (Bob) Krzaczek, RIT (Software Engr.)
- Deputy Systems Engineer: R. Shuping, UCLA (Research Scientist)
- Science Advisor: G. Sandell, USRA (Senior Scientist)
- Deputy Science Advisor: J. Kastner, RIT (Staff Scientist)

DCS Status: Achievements to Date

Conceptual Design Review	**Jun 99**
Preliminary Design Review	**Mar 00**
Rudimentary pipeline demonstrated (HAWC simulator)	**Nov 00**
ISO Archive interface to Archive Demo	**Nov 00**
FITS keyword dictionary established	**Nov 01**
Basic Archive functionality (read in, search, retrieve)	**Jan 02**
Basic Core functionality	**Mar 02**
Web-based integration time calculators demo	**May 02**

DCS Schedule: Future Events

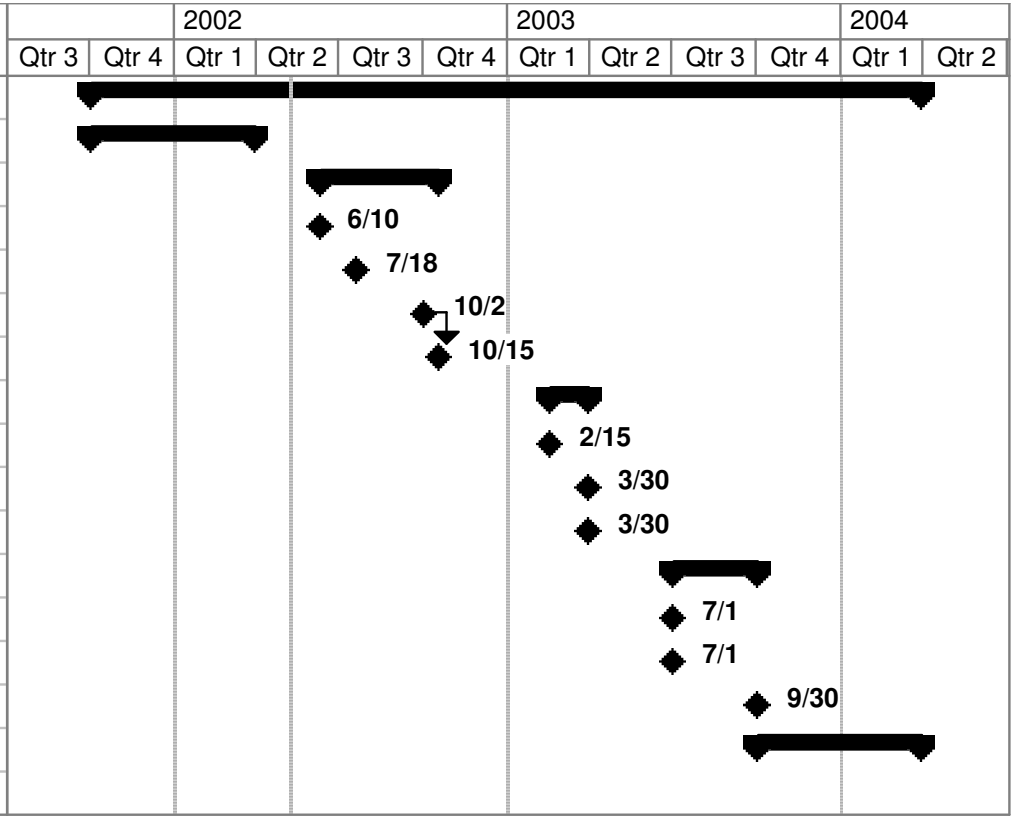
- New builds of Core and Archive released every 6 months: increase capabilities incrementally

Software Requirements Document Release	**Aug 02**
Integrated Prototype Complete	**Oct 02**
DCS / FLITECAM Integration Complete	**Feb 03**
DCS Final Design Review	**Apr 03**
DCS / FORCAST Integration Complete	**Apr 03**
Complete Proposal Tool & Obs. Planning tool	**Oct 03**
Min. Sci. Req. implemented & SSMOC integrated	**Apr 04**
Released for use	**Oct 04**

After release, other Facility and PI Instrument modes will be added, pipelines (including quick-look) will be improved, tools will be enhanced.

DCS (Integration) Schedule

ID	Task Name
1	**Develop DCS**
2	**Phase 1, Sys Requirements & Planning**
8	**Phase 2, Core & Archive Integration (Summary)**
9	DCS Core/Archive TIM
10	DCS/FSI TIM
11	Interoperability Demonstration
12	Deliver Integrated DCS Prototype
13	**Phase 3, Initial Instrument Integration**
14	DCS/FLITECAM Integration Complete
15	DCS Archive/HIPO Integration Complete
16	DCS Core/FORCAST Integration Complete
17	**Phase 4, Instrument Integration**
18	DCS Archive/FORCAST Integration Complete
19	DCS Core/HAWC Integration Complete
20	DCS Archive/HAWC Integration Complete
21	**Phase 5, SSMOC Integration**



Calendar years shown

Remaining DCS Work

- Core
  - Robust pipeline architecture
  - Implement real AOTs to produce real AORs
- Archive
  - Store housekeeping data
  - Coding for actual specific instruments
- Integration
  - Core, Archive, MCS, Instruments
  - Code Unified User Interface (based on Core interface)
- Planning
  - Select and adapt tools for observation planning & proposals

SUMMARY: DCS is 35% Complete
DCS is 45% Spent

DCS Budget

Expenditures / Budget ($K)

Org	FY99	FY00	FY01	FY02	FY03	FY04	Total
USRA	26	134	118	65	170	910	1423
RIT	48	250	525	275	275		1373
UCLA	10	91	147	250	325	250	1188
Sterling		55	60				115
Ames	int.	int.	50	100			150
TOTAL	84	530	900	690	770	1160	4134

Funding ($K)

Source	FY99	FY00	FY01	FY02	FY03	FY04	Total
SOFIA		314	750	540	770	1160	3534
R&A	84	216	150	150			600
TOTAL	84	530	900	690	770	1160	4134

Top DCS Concerns (and mitigations)

- Budget profile does not meet development needs: risk of late delivery or delivery without adequate capabilities
- Are there adequate resources and planning devoted to DCS integration and testing?
- Budget is probably inadequate:
  - No reserve; some minimum components are not currently allocated or funded
  - Currently 35% complete but 45% spent
  - No funding provided to facility instrument teams for interfacing

<u>These concerns are mitigated by:</u>

1) We can now track progress with the (new) DCS schedule; Resources will be reallocated based on other program needs.
2) Ames scientists have been helping with development; more Ames involvement is possible.
3) USRA has already reallocated $100K to DCS for FY03